mental processes of anabolism, katabolism, and growth as slow chemical reactions catalytically accelerated by protoplasm and inevitably accelerated by temperature. This soon follows if we once admit that the atoms and molecules concerned possess the same essential properties during their brief sojourn in the living nexus as they do before and after.

Perhaps the more real question is rather as to the importance and significance of this point of view. Protoplasmic activity might be something so much *per se*, and the other factors of the nature of stimuli might be superposed so thickly upon that substratum which should be dominated by simple principles of chemical mechanics that for practical purposes the operations of the latter would be so overlaid and masked as to be negligible. A survey of this field, however, seems to show that this is not so, and that the broad action of the law of mass and the acceleration of reaction-velocity by temperature are obviously responsible for wide ranges of phenomena.

Now the conception at the bottom of these principles is that of reaction-velocity, and the conclusion of the whole matter is that the physiologist must frankly take over from physical chemistry this fundamental conception.[1] Under definite conditions of supply of material and temperature there is a definite reaction-velocity for a given protoplasm, and the main factors that alter the rate of metabolism, viz., heat, nutrition, and traces of impurities are exactly the factors which affect the velocity of reactions *in vitro*.

Working on this basis we no longer need the vague unquantitative terminology of stimulation for the most fundamental of the observed "responses" to external conditions. Three sets of phenomena we have observed which, though usually treated in the category of stimulation, draw a clearer interpretation from the conception of reaction-velocity. These were: (1) the relation of development to the absence or deficit of single essential food constituents; (2) the occasional striking effect of minute traces of added foreign substances upon the whole rate of growth and metabolism; and (3) the general doubling of the activity of vital processes by a rise of 10° C.

The next higher stratum of principles should be the complications introduced by limiting factors which interrupt the extent of the manifestations of these principles and by various correlations, as, for example, that by which the reaction-velocity of one catabolic process might withdraw the supply of material needed for full activity of another different process. To this sort of relation may be attributed that phenomenon so characteristic of the more complex vital processes and quite unknown in the inorganic world, namely, the optimum.

Finally, superposed upon all this comes the first category of phenomena that we are content still to regard as stimulatory. From the point of view of metabolism and reaction-velocity many of these appear very trivial, though their biological importance may be immense. Think how little the tropistic curvatures of stems and roots affect our quantitative survey; yet a little re-arrangement of the distribution of growth on the two sides of an organ may make the difference between success and failure, between life and death.

From our present point of view vision does not extend to the misty conceptions of stimulation upon our horizon. We may therefore postpone speculation upon the mechanical principles governing them and await the time when by scientific operations we shall have reduced to law and order the intervening region, which we may entitle the chemical substratum of life. This done we may venture to pitch our laboratory a march nearer to the phenomena of protoplasmic irritability and make direct attack upon this dominating conception, the first formidable bulwark of vital territory.

[1] No general treatment of the physiology of plants has yet been attempted in terms of reaction-velocity. Czapek, however, in the introduction to his stupendous "Biochemie der Pflanzen," vol. i., 1905, does direct attention to the conception of "reaction-velocity" and refer to the standard literature on this subject and on catalysis, though direct application is not made to the plant. Cohen ("Physical Chemistry for Physicians and Biologists," English edition, 1903) considers in detail some biological applications of the acceleration of reactions by temperature.

THE SCIENTIFIC STUDY OF PLAGUE.

THE fourth extra number of the *Journal of Hygiene*, containing the work of the Plague Commission, has appeared lately.[1] Chapter xxvi.—the first of this number—is a translation of a St. Petersburg thesis (1904) by Dr. Verjbitski, which has not been published before. The Russian worker arrived independently at conclusions, with regard to the transmission of plague by blood-sucking parasites, which tally well with those of the Indian workers. The common rat flea of Cronstadt, however, is *Typhlopsylla musculi*, and appears not to attack man. Experiments with bugs gave results similar to those with fleas.

Chapter xxvii. is the substance of a report submitted to the Indian Government by Lieut.-Colonel Bannerman and R. J. Kápadiâ in 1904. It shows that domestic animals (pigs, calves, fowls, turkeys, geese, and ducks) are not susceptible to a general infection with *B. pestis*, though local abscesses were sometimes produced by inoculation.

Chapter xxviii. gives some experiments on septicæmia in human plague, with others on the infectivity of excreta, supplementary to work detailed in an earlier number of these reports.

The most interesting portion of this number is contained in chapters xxix. to xxxi., dealing with the bionomics of fleas, the mechanism by means of which the flea clears itself of plague bacilli, and the seasonal prevalence of plague.

Simple and ingenious are the methods of carrying out flea experiments here described. The results, too, are interesting. It is found that fleas do not remain constantly on their host, but hop off on to the floor or into the nest of the rat. Here the eggs are laid, and, when the fleas seek food again, it is likely that a different rat will supply the meal. In this way the same flea may bite several rats in the course of the day, and forms a very efficient means of spreading infection. Not only this, but the experiments prove that, where many rat fleas are present (*P. cheopis*), some of them will readily attack man, though rats are at hand.

The developmental stages of the flea are passed through in three weeks in favourable circumstances. Temperature above 80° F. has a retarding influence, which becomes very marked between 85° F. and 90° F. At these temperatures fewer eggs are laid, and their development is slower than at lower temperatures such as 70° F.

Passing to the consideration of the seasonal prevalence of plague, we find that though climatic conditions go for something, yet they leave much to be explained. Charts are given which show the recurrent plague epidemics in six widely different localities, along with temperature and humidity curves. Humidity appears to have little importance. With regard to temperature, the following conclusions are drawn:—

(1) A plague epidemic is checked when the mean daily temperature passes above 80° F., and especially when it reaches 85° F. or 90° F.

(2) A mean temperature above 80° F. affects the conditions to which the plague bacillus is subjected in the stomach of the flea. At high temperatures, about 90° F., the plague bacilli disappear from the stomach of the flea much more quickly than at lower temperatures, namely, between 70° F. and 80° F.

(3) A plague epidemic may, however, come to an end when the temperature is most suitable. Other factors must therefore be present in these cases.

Reading further, we find these "other factors," tending to check an epidemic, are a diminution in the number of rat fleas, a diminution in the total number of rats, and an increase in the proportion of immune to susceptible rats. Perhaps the first of these factors is the least important; chart vii. shows that in Bombay, in 1907, the epizootics (in both *M. decumanus* and *M. rattus*), and even the epidemic, began to decline a month before the flea infestation showed any decrease.

The last two factors are consequences of the outbreak

[1] Reports on Plague Investigations in India. *Journal of Hygiene*, vol. viii., No. 2. Pp. 148; Charts vii. Cambridge: University Press, May, 1908.) Price 6*s*.

of plague itself, so that an epizootic has only to reach a certain intensity in order to bring about its own decline. It is difficult to estimate the decrease in rat population caused by an epizootic, but the systematic trapping carried out in the Punjab villages of Kasel and Dhand gave results which seem to indicate that this decrease may be considerable. An increase in the proportion of immune rats has a double action. First, it obviously connotes a decrease in the available number of susceptible rats; secondly, these immune rats actually protect their susceptible companions. For consider an infected flea which has just left a rat dead of plague. Such a flea is dangerous only so long as he carries living plague bacilli in his stomach. But the Commission has shown that the destruction of plague bacilli within the flea's stomach is largely effected by the activity of the rat's leucocytes, taken in at each fresh meal. But efficient phagocytosis depends on efficient opsonisation, so that if the infective flea chances to take a meal from an immune rat, the opsonic power of the blood of which is generally above normal, the phagocytic process will be hastened, and the flea will be less dangerous to his next susceptible host. This deduction was tested in an experiment in which fleas were first infected and then fed for twenty-four hours, one series on immune rats and another series on susceptible rats. The two lots of fleas were then allowed to feed on normal guinea-pigs, of which the immune-fed fleas infected only four out of eleven, while the others infected eight out of eleven. But we are led to expect further experiments on this interesting topic.

The number concludes with some brief remarks of the differential diagnosis of *B. pestis*. L. NOON.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—A course of eight lectures on "Algal Flagellates and the Lines of Algal Descent" will be begun by Dr. F. E. Fritsch at University College on October 26. During the second term a course of eight lectures on "Physical Chemistry and its Bearing on Biology" will be delivered by Dr. J. C. Philip, and in the third term a course of eight lectures on "Recent Advances in the Study of Heredity" will be delivered by Mr. A. D. Darbishire. A course of four lectures on "The Geological Structure of the Area of the Vosges" will be delivered at Bedford College by Miss C. A. Raisin, beginning on November 16, and in the second and third terms courses will be given at University College by Dr. A. Smith Woodward, F.R.S., and Prof. E. J. Garwood on, respectively, "The Use of Fossil Vertebrata in Stratigraphical Geology" and "The Geology and Physiography of Arctic Europe." Beginning on January 22, Dr. W. N. Shaw, F.R.S., will give a course of lectures on "The Climates of the British Possessions." On October 20 Dr. F. S. Locke will deliver, in the physiological laboratory of the University, a course of lectures on "Some Problems of General Physiology, more Particularly those Associated with Muscle," and in the second and third terms courses will be given by Prof. A. D. Waller, F.R.S., and Dr. A. Harden on, respectively, "General Physiology of Nerve" and "Chemical Biology of the Yeast Cell." On February 2 Dr. L. C. Parkes will begin, at University College, a course of four lectures on "The Medical Aspects of Recent Advances in Hygiene as Connected with Sewering." Prof. E. A. Minchin will in the third term give, at the Lister Institute, a course of lectures on protozoology, and in the first term Mr. R. Lydekker, F.R.S., will deliver three lectures on "The Living and Extinct Faunas of Africa and South America." Details as to the time and place of the delivery of the last-named course will be announced later. All the lectures referred to will be addressed to advanced students, and no charge will be made for admission.

University College.—The delivery of the following introductory public science lectures has been arranged for:—October 6, "Davy and Graham," by Sir William Ramsay, K.C.B., F.R.S.; October 8, "Personal Religion in Egypt," by Prof. W. M. Flinders Petrie, F.R.S.; October 8, "Gleanings in the Babylonian East," by Dr. T. G. Pinches; October 9, "Recent Developments in Philosophic Thought," by Prof. G. Dawes Hicks; October 9, "School Hygiene," by Prof. H. R. Kenwood; October 14, "The Scientific Principles of Radio-telegraphy," by Prof. J. A. Fleming, F.R.S.

Bedford College.—A course of lectures and demonstrations for teachers, and persons qualifying to be teachers, will be given on "The Hygiene of Common Life," by Dr. J. S. Edkins. The opening lecture (the admission to which will be free) will be delivered on October 13.

OXFORD.—In a Convocation to be held on October 8 it will be proposed to confer the degree of Doctor of Science, *honoris causa*, upon Dr. Svante August Arrhenius and Dr. A. G. Vernon Harcourt, F.R.S.

MR. MATTHEW MONIE has been appointed lecturer on geology at the Glasgow Agricultural College.

DR. H. BYRON HEYWOOD has been appointed assistant lecturer in the mathematical department of the East London College.

THE general prospectus of the day and evening classes to be held at the Battersea Polytechnic during the session which has just begun provides careful guidance for intending students. New classes have been arranged for advanced students in hygiene, geology, and bacteriology, and new trade classes in wheelwrights' work and gas-fitting have been inaugurated. It is satisfactory also to find that coordinated courses have been drawn up in engineering, chemistry, physics, mathematics, and other main branches of work. A building grant from the London County Council has made it possible to set about extending the laboratories for mechanical and electrical engineering, and to undertake extensive alterations and additions in the chemistry department.

THE Board of Education has issued the following list of candidates successful in the competition for the Whitworth scholarships and exhibitions, 1908:—*I. Scholarships* (125*l.* a year each, tenable for three years): W. H. Mead, Southsea; W. White, Portsmouth; W. H. Stock, Swindon; E. Bate, London. *II. Exhibitions* (50*l.*, tenable for one year): A. H. Gabb, Swindon; A. McKenzie, Devonport; R. Bassett, Devonport; S. L. Dawe, Devonport; A. J. Triggs, Devonport; A. C. Lowe, Harrogate; J. R. Pike, Portsmouth; H. R. Allison, Gillingham; A. E. Beal, Sheerness; C. R. Kemp, London; H. L. Guy, Penarth, Glamorgan; H. G. Stephens, Leicester; F. E. Rowett, Chatham; C. E. Haddy, Torpoint, R.S.O., Cornwall; W. E. Tong, Gosport; G. W. Bird, Plymouth; C. W. Limbourne, Plumstead; W. G. Pitt, Plumstead; E. J. Cox, Gosport; G. H. Reid, Stonehouse, Devon; D. Watson, Swindon; J. E. Burkhardt, Newcastle-on-Tyne; P. R. Higson, London; A. J. Sear, Portsmouth; E. O. Hale, Stantonbury, Bucks; F. C. Ham, Plumstead; A. R. C. Winn, Hornchurch, Essex; J. Scobie, London; F. Bray, Devonport; C. P. T. Lipscomb, Plumstead.

THE second section of the new buildings of the Glasgow and West of Scotland Technical College was used for the first time on Tuesday, September 22, on the occasion of admitting to the associateship of the college the students who had gained the college diploma at the close of last session. Dr. G. T. Beilby, F.R.S., chairman of the governors, presided at the meeting held in the examination hall, and in the course of an address described the relations of the college to the reform in methods of coal consumption. The college was the first institution in the United Kingdom to establish special laboratories for the teaching and study of everything connected with fuel and combustion. The most recent knowledge on these subjects shows that in the great majority of cases smoke and dust are quite unnecessary concomitants of industry. The inquiries of the recent Royal Commission on Coal Supplies have made it abundantly clear that the present inefficient consumption of coal in Great Britain not only leads to the waste of from forty to sixty million tons per annum, but that this inefficiency is also responsible for the greater proportion of the smoke and dirt from which the nation suffers. It has been estimated that on the total British consumption 30 per cent. might be saved if the best-known means of consumption for each purpose were employed. The college has as its most obvious duty the education